JSES International 7 (2023) 780–785

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Chronic steroid use as a risk factor for postoperative complications following arthroscopic rotator cuff repair

Richelle Fassler, BA[a], Kenny Ling, MD[a], Ryan Tantone, MD[b], David E. Komatsu, PhD[b], Edward D. Wang, MD[b,*]

[a]Renaissance School of Medicine at Stony Brook University, Stony Brook, NY, USA
[b]Department of Orthopaedics, Stony Brook University, Stony Brook, NY, USA

ARTICLE INFO

Keywords:
Arthroscopic rotator cuff repair
Steroids
Immunosuppressants
Shoulder
Mortality
Postoperative complications

Level of evidence: Level III; Retrospective Cohort Comparison Using Large Database; Prognosis Study

Background: Steroids are a common treatment for many rheumatologic and inflammatory disorders. Chronic steroid use has been studied in joint arthroplasty and arthroscopy, but studies specifically on preoperative chronic steroid use in arthroscopic rotator cuff repair (aRCR) are limited. The purpose of this study is to determine the association between chronic steroid use and 30-day postoperative outcomes following aRCR.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (NSQIP) was queried to identify all patients who underwent aRCR between 2015 and 2020. Patients were divided into 2 cohorts: nonsteroid users and chronic steroid users. Univariate binomial regression analysis was used to compare demographics, comorbidities, and postoperative outcomes between cohorts. Multivariate regression analysis, adjusted for all significant demographics and comorbidities, was used to identify significant 30-day postoperative outcomes.

Results: A total of 39,876 patients remained after exclusion criteria, with 39,068 (97.97%) in the nonsteroid group and 808 (2.02%) in the chronic steroid group. Patient demographics and comorbidities significantly associated with chronic steroid use were age ≥65 ($P < .001$), female gender ($P < .001$), body mass index (BMI) ≥35, American Society of Anesthesiologists (ASA) ≥3 ($P < .001$), dependent functional status ($P < .001$), nonsmokers ($P = .046$), higher rates of dyspnea ($P < .001$), chronic obstructive pulmonary disease (COPD) ($P < .001$), congestive heart failure ($P < .001$), hypertension requiring medication ($P < .001$), open wound infection ($P = .018$), unintentional weight loss ($P < .001$), bleeding disorders ($P < .001$), and inpatient procedure ($P = .013$). Multivariate analysis found preoperative chronic steroid use to be an independent predictor of mortality within 30 days following aRCR (OR 8.15, confidence interval (CI) 1.45-45.86; $P = .017$).

Conclusion: Chronic steroid use was not found to be an independent risk factor for infection, readmission, or reoperation following aRCR. It was, however, found to be independently associated with higher rates of 30-day mortality following aRCR, although with a limited overall number of deaths reported.

Rotator cuff tear is a common orthopedic injury, reported to occur in about 20% of the general population.[29] Untreated tears can result in pain, decreased range of motion, pseudoparalysis, and rotator cuff tear arthropathy.[9,19] Surgical rotator cuff repair prevents tear progression and restores the proper bone-tendon interface, thus decreasing the need for future surgery compared to nonoperative treatments.[3] Arthroscopic rotator cuff repair (aRCR) has become the gold standard surgical treatment for both small and large rotator cuff tears, with its use increasing by approximately 50% in the recent years.[8] When compared to open rotator cuff repair, it has demonstrated equal or better outcomes, with decreased retear incidence, decreased pain, and increased mobility.[2,17,18]

Patients undergoing rotator cuff repair have been found to have higher rates of comorbidities, including hypertension, diabetes, hypercholesterolemia, peripheral vascular disease, and chronic pulmonary disease, with a greater rate of increase over time when compared to a random sample of the commercially insured US population.[5,30] Corticosteroids and immunosuppressive therapy

Institutional review board approval was not required for this study.

*Corresponding author: Edward D. Wang, MD, Department of Orthopaedics, Stony Brook University Hospital, HSC T-18, Room 080, Stony Brook, NY 11794-8181, USA.
E-mail address: Edward.Wang@stonybrookmedicine.edu (E.D. Wang).

https://doi.org/10.1016/j.jseint.2023.05.015

are effective treatments prescribed for numerous diseases such as rheumatoid arthritis, systemic lupus erythematosus (SLE), inflammatory bowel disease (IBD), systemic vasculitis and several other conditions.[16,31] However, chronic use of these medications can lead to various health complications such as increased risk of infection, osteoporosis, avascular necrosis, glaucoma, diabetes mellitus, and cardiovascular disease.[31]

In orthopedic surgery, chronic steroid use has been shown to be an independent predictor of readmission in general shoulder and knee arthroscopy, as well as in open shoulder surgeries.[1,11,28] Corticosteroid use has also been associated with higher likelihood of inpatient procedures for primary and reverse total shoulder arthroplasty, although overall trends show increasing outpatient performance of shoulder arthroplasty.[26]

Overall, the effects of chronic steroid use in aRCR outcomes remains largely understudied. With the growing utilization of aRCR, further investigation into the interplay between patient's health conditions and chronic steroid use is necessary to understand what adverse outcomes may arise after aRCR. The objective of this study was to identify patient demographics and comorbidities associated with steroid use and to investigate associations between preoperative chronic steroid use on 30-day postoperative outcomes following aRCR. We hypothesize that chronic preoperative steroid use will be a risk factor for infection, readmission, and reoperation.

Materials and methods

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was queried to identify all patients who underwent aRCR between 2015 and 2020. The NSQIP database, operated by trained surgical clinical reviewers, collects information on surgical patients from over 600 hospitals nationwide. Well-defined criteria are used to identify variables including demographics, comorbidities, and 30-day outcomes. The data are periodically audited to maintain its accuracy and validity.[24] Variables collected in this study included chronic steroid use, patient demographics, comorbidities, functional status, postoperative complications, discharge destination, readmission rates, and reoperation rates.

The Current Procedural Terminology (CPT) code 29827 was used to identify patients who underwent aRCR. These patients were divided into 2 cohorts based on preoperative chronic steroids and immunosuppressant use. This variable includes patients requiring regular administration of oral or parenteral corticosteroids or immunosuppressive medications for a chronic medical condition, within 30 days before surgery. Long-interval injections or long-acting agents that are part of an ongoing regimen were included. Short immunosuppressant course, one-time pulse, or short taper were not included in NSQIP data collection. Topical corticosteroids applied to the skin or corticosteroids administered by inhalation or rectally were also not included. Examples of corticosteroid medications include, but are not limited to prednisone and decadron.

Patient demographics collected in this study include age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, functional status, smoking status, and chronic steroid use. Patient comorbities including diabetes, dyspnea, chronic obstructive pulmonary disease, ascites, congestive heart failure (CHF), hypertension, renal failure, dialysis, disseminated cancer, open wound infection, unintentional weight loss, and bleeding disorders were collected. Intraoperative variables indicating inpatient or outpatient procedure were also collected.

Postoperative complications that occurred within 30 days of surgery included surgical and medical complications. Surgical complications included superficial surgical site infection (SSI), deep SSI, organ/space SSI, wound dehiscence, and reoperation. Major medical complications included stroke/cerebral vascular event (CVA), acute renal failure, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, blood transfusions, deep vein thrombosis/thrombophlebitis, sepsis, septic shock, failure to wean off ventilator >48 hours, reintubation, readmission, and mortality. Minor medical complications include pneumonia, progressive renal insufficiency, and urinary tract infection (UTI). Discharge destination, home vs. nonhome discharge was also included in this analysis.

A total of 40,715 patients who underwent aRCR between 2015 and 2020 were identified. Patients were excluded as follows: 320 for missing height or weight, 455 for missing functional status, 56 for missing ASA class, and 1 patient for missing sex. After these exclusion criteria, 39,876 patients remained. These patients were divided into cohorts based on preoperative chronic steroid use: 39,068 (97.97%) in the nonsteroid cohort and 808 (2.03%) in the chronic steroid cohort (Fig. 1).

All statistical analyses were completed using SPSS Software version 29.0 (IMB Corp., Armonk, NY, USA). Patient demographics and comorbidities were compared between cohorts using univariate binomial logistic regression analysis. Multivariate binomial logistic regression was then used to adjust for statistically significant demographics and comorbidities to identify relationships between preoperative chronic steroid use and postoperative complications. Odds ratios were reported for 95% confidence intervals (CIs). Significance was set to $P < .05$.

Results

Of the 39,876 patients identified, 808 (2.02%) patients were in the chronic steroid cohort, and 39,068 (97.98%) patient were in the nonsteroid cohort. Compared to the nonsteroid cohort, chronic steroid users had significantly higher rates of age $\geq$65 ($P < .001$), female gender ($P < .001$), body mass index (BMI) $\geq$35 ($P < .01$), ASA $\geq$3 ($P < .001$), dependent functional status ($P < .001$), and nonsmokers ($P = .046$) (Table I). Patients in the chronic steroid use cohort also had significantly higher rates of dyspnea ($P < .001$), chronic obstructive pulmonary disease (COPD) ($P < .001$), CHF ($P < .001$), hypertension requiring medication ($P < .001$), open wound infection ($P = .018$), unintentional weight loss ($P < .001$), bleeding disorders ($P < .001$), and inpatient procedure ($P = .013$) (Table I). Steroid use was not associated with diabetes ($P = .069$), ascites ($P = .999$), dialysis ($P = .29$), or disseminated cancer ($P = .415$) (Table I).

Postoperative complications associated with chronic steroid and immunosuppressive use were analyzed using univariate binomial logistic regression. UTI ($P = .010$), nonhome discharge ($P = .002$), and mortality ($P < .001$) were found to be significantly associated with preoperative chronic steroid use (Table II).

Multivariate binomial logistic regression adjusted for significant demographics and comorbidities found preoperative chronic steroid use to be an independent predictor of mortality within 30 days following aRCR (OR 8.15, CI 1.45-45.86; $P = .017$). Chronic steroid use was no longer significant for UTI (OR 2.36, 95% CI 0.94-5.96; $P = .069$) or nonhome discharge (OR 1.43, 95% CI 0.71-2.88; $P = .314$) (Table III).

Discussion

In this study, we investigated the association between preoperative chronic steroid and immunosuppressive use and 30-day postoperative complications in patients undergoing aRCR between 2015 and 2020 using a large national database. Through univariate binomial logistic regression, we identified chronic steroid use to be a risk factor for UTI, nonhome discharge, and mortality. After adjusting for statistically significant comorbidities and

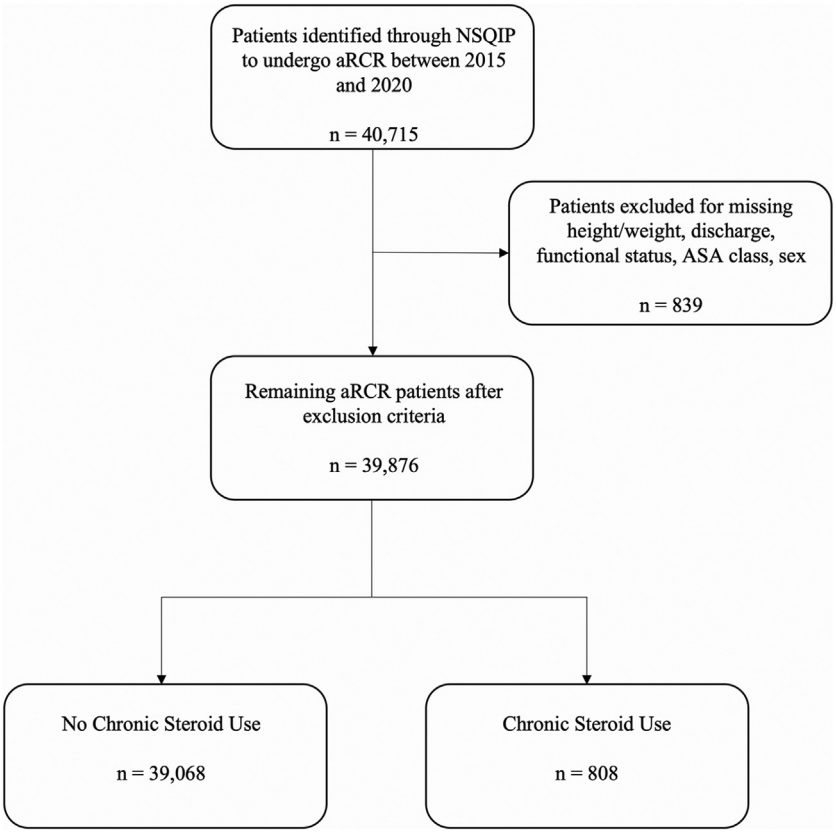

Figure 1 Inclusion and exclusion criteria for nonsteroid and chronic steroid cohorts. *NSQIP*, National Surgical Quality Improvement Program; *aRCR*, arthroscopic rotator cuff repair; *ASA*, American Society of Anesthesiologists.

demographics, we identified preoperative chronic steroid use as an independent risk factor for mortality following aRCR.

Corticosteroids are used in the treatment of many immunologic and inflammatory diseases, such as rheumatoid arthritis, IBD, asthma, and some malignancies.[25,31] They exhibit anti-inflammatory, immunosuppressive, anti-proliferative, and vasoconstrictive effects through alteration of gene transcription involved in host inflammatory response.[16,20,25] This results in synthesis of anti-inflammatory proteins and repression of proinflammatory factors, such as nuclear factor-kB and activator protein.[25] These modifications can inhibit neutrophil chemotaxis and immune cell activation, decrease tensile strength of scar tissue, and lead to inadequate cortisol production during stress responses such as surgical procedures.[1]

Long term use of corticosteroids has been associated with multiple adverse effects. Well-documented adverse effects include osteoporosis, impaired healing, diabetes, hypertension, gastrointestinal disease, cardiovascular disease, and psychiatric disturbances.[16,23] In surgery specifically, chronic steroid use has been associated with increased surgical complications and worse surgical outcomes.[5,12]

The gold standard treatment for rotator cuff tear is aRCR. Its use has yielded same or better operative outcomes when compared to open rotator cuff repair (RCR). Arthroscopic repair has demonstrated consistently high UCLA shoulder scores, overall functional improvement, and quicker recovery.[21] aRCR has outnumbered open RCR in the recent years, with its use increasing from 56.9% in 2007 to 75.1% in 2015.[8] As the utilization of aRCR continues to rise, it is important to understand risk factors to minimize adverse postoperative outcomes.

Chronic steroid use is an important risk factor to study due to potential adverse effects on tendons. Multiple biomechanical studies on rotator cuff tendons showed that steroid injections can decrease its maximum load to failure and stiffness by altering the tissue on a molecular level (decreased cellular proliferation, altered extracellular matrix composition, and increased apoptosis).[22] These biomechanical analyses also showed that preoperative steroid injections led to a lower suture anchor pull-out strength after RCR.[22] Furthermore, chronic steroid use has been found to increase risk of infection, poor wound healing, length of hospital stay, readmission and reoperation rates, and risk of death.[5,12]

It is well known that chronic steroid use has been associated with postoperative infection in multiple surgical settings, including within orthopedics. Following total knee and hip arthroplasty (TKA and THA, respectively), chronic steroid use has been linked to postoperative surgical site infection, organ space infection, periprosthetic joint infection, wound dehiscence, and urinary tract infection.[4,14,32] Following TKA specifically, a study by Curtis et al found patients on chronic immunosuppressants were at increased risk of infection, wound dehiscence, urinary tract infection, and sepsis.[7] THA has reported similar results, demonstrating that chronic immunosuppressant use was an independent risk factor for septic shock.[6] Within shoulder surgery, chronic steroid use has been found to be an independent predictor for infectious complications, including sepsis, superficial infection, and deep infection.[1]

Readmission and reoperation are 2 additional postoperative outcomes that have commonly been reported in association with chronic steroid use.[11,15,28] For example, following THA there are multiple studies demonstrating chronic steroid use as an independent risk factor for readmission.[6,10] Following TKA, both

Table I
Univariate binomial logistic regression for patient demographics and comorbidities in both nonsteroid and chronic steroid group.

Characteristic	Nonsteroid		Chronic steroid		*P* value
	Number	Percent (%)	Number	Percent (%)	
Total	39,068	100	808	100	
Age					**<.001**
18-39	2000	5.12	13	1.61	
40-64	25,554	65.41	505	62.50	
65-74	9421	24.11	235	29.08	
≥75	2093	5.36	55	6.81	
Gender					**<.001**
Female	15,765	40.35	453	56.06	
Male	23,303	59.65	355	43.94	
Body mass index (kg/m^2)					**<.001**
<18.5	149	0.38	4	0.50	
18.5-29.9	19,586	50.13	377	46.66	
30-34.9	10,727	27.46	196	24.26	
35-39.9	5138	13.15	115	14.23	
≥40	3468	8.88	116	14.36	
ASA classification					**<.001**
1-2	25,761	65.94	318	39.36	
≥3	13,307	34.06	490	60.64	
Functional status					**<.001**
Independent	38,936	99.66	797	98.64	
Dependent	132	0.34	11	1.36	
Smoking					**.046**
No	33,298	85.23	709	87.75	
Yes	5770	14.77	99	12.25	
Outpatient/Inpatient					**.013**
Outpatient	37,880	96.96	771	95.42	
Inpatient	1188	3.04	37	4.58	
Diabetes					.069
No	32,636	83.54	665	82.30	
Noninsulin	4668	11.95	90	11.14	
Insulin	1764	4.52	53	6.56	
Dyspnea					**<.001**
No	37,919	97.06	755	93.44	
Moderate exertion	1103	2.82	50	6.19	
At rest	46	0.12	3	0.37	
COPD					**<.001**
No	38,012	97.30	751	92.95	
Yes	1056	2.70	57	7.05	
Ascites					.999
No	39,065	99.99	808	100.00	
Yes	3	0.01	0	0.00	
Congestive heart failure					**<.001**
No	39,023	99.88	802	99.26	
Yes	45	0.12	6	0.74	
Hypertension					**<.001**
No	21,611	55.32	346	42.82	
Yes	17,457	44.68	462	57.18	
Renal failure					.999
No	39,064	99.99	808	100.00	
Yes	4	0.01	0	0.00	
Dialysis					.29
No	39,023	99.88	806	99.75	
Yes	45	0.12	2	0.25	
Disseminated cancer					.415
No	39,047	99.95	807	99.88	
Yes	21	0.05	1	0.12	
Open wound infection					**.018**
No	39,033	99.91	805	99.63	
Yes	35	0.09	3	0.37	
10% weight loss					**<.001**
No	39,029	99.90	803	99.38	
Yes	39	0.10	5	0.62	
Bleeding disorders					**<.001**
No	38,558	98.69	777	96.16	
Yes	510	1.31	31	3.84	

Bold *P*-values indicate statistical significance with $P < .05$.
ASA, American Society of Anesthesiologists; *COPD*, chronic obstructive pulmonary disease.

Table II
Univariate binomial logistic regression of postoperative complications in both nonsteroid and chronic steroid groups.

Postoperative complication	Nonsteroid		Chronic steroid		*P* value
	Number	Percent (%)	Number	Percent (%)	
Superficial SSI	51	0.131	0	0.000	.998
Deep SSI	18	0.046	0	0.000	.999
Organ space SSI	13	0.033	1	0.124	.206
Wound disruption	6	0.015	0	0.000	.999
Reoperation	104	0.266	1	0.124	.063
Stroke/CVA	10	0.026	0	0.000	.999
Acute renal failure	4	0.010	0	0.000	.999
Cardiac arrest	5	0.013	0	0.000	.999
Myocardial infarction	26	0.067	2	0.248	.073
Bleeding transfusions	4	0.010	0	0.000	.999
DVT/Thrombophlebitis	55	0.141	2	0.248	.433
Sepsis	21	0.054	1	0.124	.415
Septic shock	3	0.008	0	0.000	.999
Failure to wean	8	0.020	1	0.124	.09
Reintubation	14	0.036	0	0.000	.999
Readmission	382	0.978	11	1.361	.277
Mortality	6	0.015	2	0.248	**<.001**
Pneumonia	54	0.138	1	0.124	.913
Progressive renal insufficiency	6	0.015	0	0.000	.999
Urinary tract infection	74	0.189	5	0.619	**.01**
Nonhome discharge	177	0.453	10	1.238	**.002**

Bold *P*-values indicate statistical significance with $P < .05$.
SSI, surgical site infection; *CVA*, cerebral vascular accident; *DVT*, deep vein thrombosis.

Table III
Multivariate binomial logistic regression of significant postoperative complications, adjusted for all statistically significant demographics and comorbidities.

Postoperative complications	Odds ratio	95% CI	*P* value
Urinary tract infection	2.36	0.94-5.96	.069
Nonhome discharge	1.43	0.71-2.88	.314
Mortality	8.15	1.45-45.86	**.017**

Bold *P*-values indicate statistical significance with $P < .05$.
CI, confidence interval.

readmission and reoperation have also been associated with preoperative steroid use.[7,28] Additionally, a study by Westermann et al suggests that wound complications are the most likely reason for readmission following TKA.[28] Similarly, following total shoulder arthroplasty, chronic steroid use has been found to be an independent risk factor for readmission.[15] Moreover, studies on multiple different shoulder surgeries (arthroscopy, shoulder stabilization, and related procedures), have shown chronic steroid use to be a risk factor for readmission.[1,11,28]

In contrast, our study did not find steroid use to be an independent risk factor for postoperative infection, readmission, or reoperation following aRCR. However, we did find urinary tract infection and nonhome discharge to be associated with chronic steroid use following aRCR. The studies described above analyzed open joint arthroplasties. In contrast, arthroscopic surgeries are minimally invasive. This has the potential to decrease the likelihood of infection and unfavorable outcomes, as prior studies have reported decreased risk for infection following aRCR when compared to open RCR.[13,27] This could explain our lack of significance found for postoperative infection, as well as readmission and reoperation. Therefore, arthroscopic surgery may provide the patient with decreased risk of adverse outcomes.

A secondary finding of our study is that preoperative chronic steroid and immunosuppressant use is an independent risk factor for mortality following aRCR. However, we do acknowledge that the overall number of deaths in our analysis is low, and the specific cause of death is unable to be determined from the NSQIP database. Chronic steroids as a risk factor for mortality has not been found in orthopedics to date; however, perioperative analysis on surgical patients has found increased risk of death in the chronic steroid cohort.[5] Moreover, a study by Ismael et al found a 4-fold increase in postoperative mortality with chronic preoperative steroid use.[12] This increased risk of mortality is explicable considering patients on chronic steroids often are suffering from chronic illness which may make them higher risk surgical candidates.

The purpose of our study was to report the increased rates of comorbidities and adverse outcomes in patients with chronic steroid use, so that physicians can ensure proper counseling of their patients prior to surgeries. Additionally, patients may benefit from being educated by their providers to manage common comorbidities and decrease risk of adverse outcomes following surgery.

This study is limited to the information that is available through the NSQIP database. Our data was limited to 30-day complications following surgery, and therefore we could not account for complications outside of this 30-day period. Potential long-term complications such as joint instability, retear, or reoperation after 30 days were not able to be included. Furthermore, the broad categorical format of the NSQIP database restricted our ability to analyze potential contributing factors to outcomes, such as rotator cuff tear size, length of time from tear to operation, location of the surgery, and skill level of the physician. Although we found chronic steroid use to be a risk factor for mortality following aRCR, we were unable to define causes of mortality in this patient population. Despite these limitations, we used a large national database to investigate the comorbidities and demographics associated with chronic steroid use and its adverse outcomes following aRCR. We did not find preoperative chronic steroid use to be a risk factor for infection, readmission, or reoperation. Furthermore, this is the first study to identify mortality as a significant adverse outcome of chronic steroid use in patients undergoing aRCR.

Conclusion

In contrast to previously reported orthopedic studies, we did not find chronic steroid use to be associated with increased risk of postoperative infection, readmission, or reoperation following aRCR. Preoperative chronic steroid and immunosuppressant use

were found to be independently associated with mortality following aRCR. Furthermore, chronic steroid and immunosuppressant use was also significantly associated with UTI and nonhome discharge following aRCR. As the utilization of aRCR continues to increase, it is important to investigate and understand the risks that accompany the procedure. This knowledge can guide surgeons and physicians in preoperative management and patient education to properly manage their chronic illnesses and avoid adverse outcomes.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Aziz KT, Best MJ, Ren M, Nayar SK, Timothy Kreulen R, Gupta HO, et al. The impact of chronic steroid use on early postoperative complications in shoulder surgery. Phys Sportsmed 2021;49:223-8. https://doi.org/10.1080/00913847.2020.1811616.
2. Buess E, Steuber KU, Waibl B. Open versus arthroscopic rotator cuff repair: a comparative view of 96 cases. Arthroscopy 2005;21:597-604. https://doi.org/10.1016/j.arthro.2005.01.002.
3. Chalmers PN, Ross H, Granger E, Presson AP, Zhang C, Tashjian RZ. The effect of rotator cuff repair on natural history: a systematic review of intermediate to long-term outcomes. JB JS Open Access 2018;3:e0043. https://doi.org/10.2106/jbjs.Oa.17.00043.
4. Chen FM, Fryer GE Jr, Phillips RL Jr, Wilson E, Pathman DE. Patients' beliefs about racism, preferences for physician race, and satisfaction with care. Ann Fam Med 2005;3:138-43. https://doi.org/10.1370/afm.282.
5. Chouairi F, Torabi SJ, Mercier MR, Gabrick KS, Alperovich M. Chronic steroid use as an independent risk factor for perioperative complications. Surgery 2019;165:990-5. https://doi.org/10.1016/j.surg.2018.12.016.
6. Curtis GL, Chughtai M, Khlopas A, George J, Sodhi N, Harwin SF, et al. Short-term perioperative outcomes and complications in chronic immunosuppressant users following total hip arthroplasty. J Hip Surg 2017;01:152-7. https://doi.org/10.1055/s-0037-1606614.
7. Curtis GL, Chughtai M, Khlopas A, Newman JM, Sultan AA, Sodhi N, et al. Perioperative outcomes and short-term complications following total knee arthroplasty in chronically, immunosuppressed patients. Surg Technol Int 2018;32:263-9.
8. Day MA, Westermann RW, Bedard NA, Glass NA, Wolf BR. Trends associated with open versus arthroscopic rotator cuff repair. HSS J 2019;15:133-6. https://doi.org/10.1007/s11420-018-9628-2.
9. Denard PJ, Lädermann A, Brady PC, Narbona P, Adams CR, Arrigoni P, et al. Pseudoparalysis from a massive rotator cuff tear is reliably reversed with an arthroscopic rotator cuff repair in patients without preoperative glenohumeral arthritis. Am J Sports Med 2015;43:2373-8. https://doi.org/10.1177/0363546515597486.
10. Hartwell MJ, Morgan AM, Johnson DJ, Nicolay RW, Selley RS, Tjong VK, et al. Risk factors for 30-day readmission following hip arthroscopy. Knee Surg Sports Traumatol Arthrosc 2020;28:1290-5. https://doi.org/10.1007/s00167-019-05415-4.
11. Hill JR, McKnight B, Pannell WC, Heckmann N, Sivasundaram L, Mostofi A, et al. Risk factors for 30-day readmission following shoulder arthroscopy. Arthroscopy 2017;33:55-61. https://doi.org/10.1016/j.arthro.2016.06.048.
12. Ismael H, Horst M, Farooq M, Jordon J, Patton JH, Rubinfeld IS. Adverse effects of preoperative steroid use on surgical outcomes. Am J Surg 2011;201:305-8; (discussion 8-9). https://doi.org/10.1016/j.amjsurg.2010.09.018.
13. Jensen AR, Cha PS, Devana SK, Ishmael C, Di Pauli von Treuheim T, D'Oro A, et al. Evaluation of the trends, concomitant procedures, and complications with open and arthroscopic rotator cuff repairs in the medicare population. Orthop J Sports Med 2017;5:2325967117731310. https://doi.org/10.1177/2325967117731310.
14. Kittle H, Ormseth A, Patetta MJ, Sood A, Gonzalez MH. Chronic corticosteroid use as a risk factor for perioperative complications in patients undergoing total joint arthroplasty. J Am Acad Orthop Surg Glob Res Rev 2020;4:e2000001. https://doi.org/10.5435/JAAOSGlobal-D-20-00001.
15. Ling K, Kim M, Nazemi A, Smolev E, Komatsu DE, Wang ED. Chronic steroid use and readmission following total shoulder arthroplasty. JSES Int 2022;6:775-80. https://doi.org/10.1016/j.jseint.2022.06.006.
16. Liu D, Ahmet A, Ward L, Krishnamoorthy P, Mandelcorn ED, Leigh R, et al. A practical guide to the monitoring and management of the complications of systemic corticosteroid therapy. Allergy Asthma Clin Immunol 2013;9:30. https://doi.org/10.1186/1710-1492-9-30.
17. MacDermid JC, Bryant D, Holtby R, Razmjou H, Faber K, Balyk R, et al. Arthroscopic versus mini-open rotator cuff repair: a randomized trial and meta-analysis. Am J Sports Med 2021;49:3184-95. https://doi.org/10.1177/03635465211038233.
18. Millar NL, Wu X, Tantau R, Silverstone E, Murrell GA. Open versus two forms of arthroscopic rotator cuff repair. Clin Orthop Relat Res 2009;467:966-78. https://doi.org/10.1007/s11999-009-0706-0.
19. Moosmayer S, Gärtner AV, Tariq R. The natural course of nonoperatively treated rotator cuff tears: an 8.8-year follow-up of tear anatomy and clinical outcome in 49 patients. J Shoulder Elbow Surg 2017;26:627-34. https://doi.org/10.1016/j.jse.2016.10.002.
20. Mundell L, Lindemann R, Douglas J. Monitoring long-term oral corticosteroids. BMJ Open Qual 2017;6:e000209. https://doi.org/10.1136/bmjoq-2017-000209.
21. Nho SJ, Shindle MK, Sherman SL, Freedman KB, Lyman S, MacGillivray JD. Systematic review of arthroscopic rotator cuff repair and mini-open rotator cuff repair. J Bone Joint Surg Am 2007;89:127-36. https://doi.org/10.2106/jbjs.G.00583.
22. Puzzitiello RN, Patel BH, Forlenza EM, Nwachukwu BU, Allen AA, Forsythe B, et al. Adverse impact of corticosteroids on rotator cuff tendon health and repair: a systematic review of basic science studies. Arthrosc Sports Med Rehabil 2020;2:e161-9. https://doi.org/10.1016/j.asmr.2020.01.002.
23. Rice JB, White AG, Scarpati LM, Wan G, Nelson WW. Long-term systemic corticosteroid exposure: a systematic literature review. Clin Ther 2017;39:2216-29. https://doi.org/10.1016/j.clinthera.2017.09.011.
24. Sebastian AS, Polites SF, Glasgow AE, Habermann EB, Cima RR, Kakar S. Current quality measurement tools are insufficient to assess complications in orthopedic surgery. J Hand Surg Am 2017;42:10-15.e1. https://doi.org/10.1016/j.jhsa.2016.09.014.
25. Smoak KA, Cidlowski JA. Mechanisms of glucocorticoid receptor signaling during inflammation. Mech Ageing Dev 2004;125:697-706. https://doi.org/10.1016/j.mad.2004.06.010.
26. Trudeau MT, Peters JJ, LeVasseur MR, Hawthorne BC, Dorsey CG, Wellington IJ, et al. Inpatient versus outpatient shoulder arthroplasty outcomes: a propensity score matched risk-adjusted analysis demonstrates the safety of outpatient shoulder arthroplasty. J ISAKOS 2022;7:51-5. https://doi.org/10.1016/j.jisako.2022.01.001.
27. Wang KY, Agarwal AR, Xu AL, Best MJ, Kreulen RT, Jami M, et al. Increased risk of surgical-site infection and need for manipulation under anesthesia for those who undergo open versus arthroscopic rotator cuff repair. Arthrosc Sports Med Rehabil 2022;4:e527-33. https://doi.org/10.1016/j.asmr.2021.11.012.
28. Westermann RW, Pugely AJ, Ries Z, Amendola A, Martin CT, Gao Y, et al. Causes and predictors of 30-day readmission after shoulder and knee arthroscopy: an analysis of 15,167 cases. Arthroscopy 2015;31:1035-1040.e1. https://doi.org/10.1016/j.arthro.2015.03.029.
29. Yamamoto A, Takagishi K, Osawa T, Yanagawa T, Nakajima D, Shitara H, et al. Prevalence and risk factors of a rotator cuff tear in the general population. J Shoulder Elbow Surg 2010;19:116-20. https://doi.org/10.1016/j.jse.2009.04.006.
30. Yanik EL, Chamberlain AM, Keener JD. Trends in rotator cuff repair rates and comorbidity burden among commercially insured patients younger than the age of 65 years, United States 2007-2016. JSES Rev Rep Tech 2021;1:309-16. https://doi.org/10.1016/j.xrrt.2021.06.009.
31. Youssef J, Novosad SA, Winthrop KL. Infection risk and safety of corticosteroid use. Rheum Dis Clin North Am 2016;42:157-76. https://doi.org/10.1016/j.rdc.2015.08.004. ix-x.
32. Zhu Y, Zhang F, Chen W, Liu S, Zhang Q, Zhang Y. Risk factors for periprosthetic joint infection after total joint arthroplasty: a systematic review and meta-analysis. J Hosp Infect 2015;89:82-9. https://doi.org/10.1016/j.jhin.2014.10.008.